Decision-Making: Types, Characteristics and Models

MS(AI-DS) lecture | 45 minutes | self-contained slides:

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Plan for the 45 minutes

Segment	Minutes	What we cover
Foundations	0–9	Why decisions matter, definition, characteristics
Types	9–19	By nature, level, knowledge and number of people
Process	19–21	The 8-step decision-making process
Models	21–31	Rational, bounded, intuitive, incremental, garbage-can
Tools and biases	31–37	Decision matrix, decision tree (EMV), cognitive biases
Class activity	37–43	Apply the decision matrix in pairs
Wrap-up	43–45	Key takeaways and questions

Learning outcomes

1

Define

Explain what decision-making is and why it matters to engineers.

2

Describe

List the characteristics that make a decision a decision.

3

Classify

Place any decision into the right type using four lenses.

4

Apply

Compare five models and use a matrix and a tree on a problem.

By the end: you can look at any engineering choice, name its type, pick a suitable model and justify the outcome.

Why engineers must learn to decide

Design

Architecture, materials, tolerances and technology stack.

e.g. Arduino or ESP32

Procurement

Choosing vendors, components and tools under cost limits.

e.g. which supplier

Projects

Scope, schedule, staffing and risk responses.

e.g. build or buy

Safety and ethics

Signing off designs where people can be harmed.

e.g. factor of safety

Key idea: decisions made early are cheap to change; the same decision after production is far more expensive.

What is decision-making?

The process of identifying a problem or opportunity, generating alternatives, evaluating them against criteria and choosing the best course of action.

1. **Purpose**
   A decision serves a goal
2. **Incomplete information**
   We rarely know everything
3. **Constraints**
   Time, cost, safety, resources

A good decision is timely, fact-based, consistent with goals, feasible and ethical.

Characteristics of decision-making

Goal-oriented
Aimed at a clear objective.

e.g. 10-hour battery life

Choice of options
At least two alternatives exist.

e.g. three sensors

Mental process
Needs analysis and judgement.

e.g. weighing cost vs reliability

Future-oriented
Outcomes are uncertain.

e.g. forecasting demand

Commits resources
Time, money, people.

e.g. prototype budget

Context-dependent
Shaped by constraints, values.

e.g. startup vs large firm

Also: decisions are continuous (one leads to the next) and carry risk and accountability.

Types of decisions: four lenses

1

By nature

Programmed (routine) or non-programmed (new).

2

By level

Strategic, tactical or operational.

3

By knowledge

Certainty, risk or uncertainty.

4

By people

Individual or group decision.

Tip: classify first. The type tells you which model and tool to use.

By nature: programmed vs non-programmed

Feature	Programmed	Non-programmed
Problem	Routine, repetitive	New, unstructured
Method	Rules, SOPs, formulas	Judgement, creativity
Usually made by	Lower management	Top management
Example	Reorder at stock level	Enter a new market

In short: if a rule can decide it, it is programmed; if it needs judgement, it is non-programmed.

By organisational level

Level	Time horizon	Made by	Engineering example
Strategic	Years	Top management	Set up a new plant
Tactical	Months	Middle management	Production schedule
Operational	Days	Supervisors, engineers	Machine settings

Rule: higher level means longer horizon, higher impact, more uncertainty and fewer rules.

By conditions of knowledge

Less knowledge, more risk

Certainty

Outcomes are known.

e.g. cheaper of two quotes for the same specification

Risk

Outcomes unknown but probabilities known.

e.g. failure rate from test data

Uncertainty

Neither outcomes nor probabilities known.

e.g. technology with no market history

Tools: certainty uses simple comparison; risk uses expected value; uncertainty uses judgement and scenarios.

By people: individual vs group

Individual

- Fast and clear accountability
- Suits routine and urgent decisions
- Risk: limited viewpoint and personal bias

Group

- More ideas, skills and acceptance
- Suits complex, high-impact decisions
- Risk: slow, conflict, groupthink

Choose by: importance, complexity and time available. High impact and complex means involve a group.

The decision-making process

1
Identify
Define the problem precisely.

2
Set criteria
What matters and how much (weights).

3
Gather information
Facts, data, constraints.

4
Generate options
List real alternatives.

5
Evaluate
Score options against criteria.

6
Select
Choose the best fit.

7
Implement
Plan, resource and act.

8
Monitor and review
Compare results and learn.

Loop: lessons from step 8 feed the next decision at step 1.

Model 1: rational (classical)

Core idea

Choose the option that maximises the outcome after full analysis.

Assumes

Complete information, all options known, stable preferences.

Strength

Systematic, logical and easy to defend.

Limitation

People rarely have full information or unlimited time.

Example: choosing a pump after testing every available model on efficiency, cost and lifetime.

Model 2: bounded rationality (Simon)

Core idea

Time, information and mental capacity are limited.

Behaviour

People satisfice: stop at the first option that is good enough.

Strength

Realistic and fast for everyday work.

Limitation

May miss a better option never examined.

Example: picking the first software library that meets every project requirement instead of benchmarking all.

Model 3: intuitive

Core idea

Quick judgement drawn from experience and pattern recognition.

Needs

A trained expert in a familiar, high-pressure situation.

Strength

Very fast; works when data is scarce.

Limitation

Hard to explain and open to bias.

Example: a senior engineer diagnosing a motor fault from its sound and vibration.

Models 4 and 5: incremental and garbage-can

Incremental (Lindblom)

- Small steps from the current position
- Compare a few options that differ slightly
- Example: software releases 1.1, 1.2, 1.3

Garbage-can (Cohen, March, Olsen)

- Problems, solutions, people and chances flow independently
- A decision happens when they meet
- Seen in loosely organised settings

Use: incremental for ongoing complex systems; garbage-can helps explain decisions that look random.

Comparing the five models

Model	Core idea	Information	Best when
Rational	Maximise	Complete	Stable, well-defined
Bounded	Satisfice	Limited	Time is short
Intuitive	Experience	Minimal	Expert, urgent
Incremental	Small steps	Partial	Complex, ongoing
Garbage-can	Chance meeting	Ambiguous	Chaotic settings

Takeaway: no model is best. Match the model to the problem, the time available and the expertise present.

Key takeaways

1. A decision is a purposeful choice among alternatives under constraints
2. Classify first by nature, level, knowledge and people; the type guides the approach
3. No model is best: rational gives structure, bounded rationality realism, intuition speed
4. Use tools and watch for biases to make your reasoning visible and reviewable

Practice questions are in the class notes. Questions?